

CLAIM

1. A method for producing water containing ozone by electrolysis, using an apparatus comprising,
- an anodic electrode (3) disposed on one side of a solid polymer electrolyte membrane (5) and having a catalyst function for generating ozone,
- a cathode electrode (4) disposed on other side of the solid polymer electrolyte membrane (5),
- a mechanism for advancing and reversing both or at least one of the electrodes (3,4) as against the solid polymer electrolyte membrane (5), wherein
- DC voltage is applied between the both electrodes (3,4) in the state of the solid polymer electrolyte membrane (5) is pressed by the both electrodes (3,4),
- water flows on both sides of the solid polymer electrolyte membrane (5),
- water containing ozone is produced at the anodic electrode (3) side by electrolysis of flowing water, further,
- an operation for changing the pressing force is carried out, in which the pressing force of the anodic electrode (3), the cathode electrode (4) or both electrodes (3,4) as against the solid polymer electrolyte membrane (5) changes in accordance with a preset condition, after that, the pressing force

returns to an original pressing force, thereby,

a recovery of the solid polymer electrolyte membrane is carried out while continuing the production of the water containing ozone.

2. The method for producing water containing ozone by electrolysis as set forth in claim 1,

the operation for changing the pressing force is carried out, in which

the pressing force of the electrodes as against the solid polymer electrolyte membrane changes with decrease, increase or these combination.

3. The method for producing water containing ozone by electrolysis as set forth in claim 1 or 2, wherein

the operation for changing the pressing force has a change pattern in which

a state that the pressing force decreases to a value less than one preset value or a state that the pressing force increases to a value more than another preset value, is maintained for a time more than a predetermined time

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4. The method for producing water containing ozone by electrolysis as set forth in any of claims 1-3, wherein

the operation for changing the pressing force is repeated with a predetermined cycle.

5. The method for producing water containing ozone by electrolysis as set forth in any of claims 1-3, wherein

at least one of a concentration (X) of ozone included in the produced water at a time point of production, an electric current value (A) flowing between the both electrodes, a voltage value (V) between the both electrodes and a volume of the produced water containing ozone, is kept under observation,

an operation for changing the pressing force against the solid polymer electrolyte membrane (5) is performed to detect that the concentration (X) of ozone included in the produced water or a manufacturing capacity deteriorates to a value less than a predetermined value, and

the operation is performed once or more times.

6. The method for producing water containing ozone by electrolysis as set forth in any of claims 1- 5, wherein,

when the solid polymer electrolyte membrane (5) is not enough recovered by the operation for changing the pressing force against the solid polymer

electrolyte membrane (5), the production of the water containing ozone is stopped, and

the both electrodes (3,4) or at least one of them is kept apart from the solid polymer electrolyte membrane (5) then

that state is held for a predetermined time, thereby

the solid polymer electrolyte membrane (5) is recovered, after that

the production of the water containing ozone is started again on a predetermined operating condition.

7. The method for producing water containing ozone by electrolysis as set forth in any of claims 1- 5, wherein,

when the solid polymer electrolyte membrane (5) is not enough recovered by the operation for changing the pressing force against the solid polymer electrolyte membrane (5), the pressing force of the electrodes (3,4) against the solid polymer electrolyte membrane (5) moves to a high value (P7, P 8) set previously, thereby

the production of the water containing ozone is continued.

8. A method for producing water containing ozone by electrolysis, wherein

an anodic electrode (3) is disposed on one side of a solid polymer electrolyte membrane (5), which is provided with a catalyst function for generating ozone,

a cathode electrode (4) is disposed on other side of the solid polymer electrolyte membrane (5),

DC voltage is applied between the both electrodes in a condition that the both electrodes (3,4) are in contact with the solid polymer electrolyte membrane (5),

water flows on both sides of the solid polymer electrolyte membrane (5),

water containing ozone is produced at the anodic electrode (3) side by electrolysis of the flowing water,

a current value of the direct-current power source (A) or a voltage value (V) changes rapidly according to a preset condition, after that, returns to an original value or the vicinity of it, thereby

a recovery treatment of the solid polymer electrolyte membrane is carried out by the above operation for changing the electric current or the voltage while continuing the production of the water containing ozone .

9. The method for producing water containing ozone by electrolysis as set forth in claim 8, wherein,
in the operation for changing the electric current or the voltage,

the electric current or voltage changes from a start point value of the operation and changes in a range between zero or a minimum value of the vicinity of it and a maximum permissible value of the apparatus for producing the water containing ozone, then the states of the minimum value and the maximum permissible value are respectively kept for a predetermined time, after that,

the electric current or the voltage changes to the original value or the vicinity of it.

10. The method for producing water containing ozone by electrolysis as set forth in claim 8 or 9, wherein the operation for changing the electric current or voltage is repeated with a predetermined cycle.

11. The method for producing water containing ozone by electrolysis as set forth in claim 8 or 9, wherein
at least one of a concentration (X) of ozone included in the produced water at a time point of production, an electric current value (A) flowing

between the both electrodes, a voltage value (V) between the both electrodes and a volume of the produced water containing ozone, is kept under observation,

the operation for changing the electric current or voltage is performed to detect that the concentration (X) of ozone included in the produced water or a manufacturing capacity deteriorates to a value less than a predetermined value, and the operation is performed once or more times.

12. The method for producing water containing ozone by electrolysis as set forth in any of claims 8-11, wherein ,

while the water containing ozone is produced to press the both of electrodes (3,4) or at least one of them to the solid polymer electrolyte membrane (5),

when the solid polymer electrolyte membrane (5) is not enough recovered by the operation for changing the electric current or voltage, the production of the water containing ozone is stopped, and

the both electrodes (3,4) or at least one of them is kept apart from the solid polymer electrolyte membrane (5) then

that state is held for a predetermined time,

thereby

the solid polymer electrolyte membrane (5) is recovered, after that,

the production of the water containing ozone is started again on a predetermined operating condition.

13. The method for producing water containing ozone by electrolysis as set forth in any of claims 8-11, wherein ,

while the water containing ozone is produced to press the both of electrodes (3,4) to the solid polymer electrolyte membrane (5),

when the solid polymer electrolyte membrane (5) is not enough recovered by the operation for changing the electric current or voltage, the pressing force of the electrodes (3,4) against the solid polymer electrolyte membrane (5) moves to a high value (P7, P 8) set previously, thereby

the production of the water containing ozone is continued.

14. An apparatus for producing water containing ozone by electrolysis, wherein,

an anodic electrode (3) having a catalyst function for generating ozone is disposed on one side

of solid polymer electrolyte membrane (5),

a cathode electrode (4) is disposed on other side of solid polymer electrolyte membrane (5),

an advance and reverse mechanism is arranged which enables the both electrodes (3,4) or at least one of them to advance and reverse against the solid polymer electrolyte membrane (5),

DC voltage is applied between the both electrodes (3,4) in the state that the both electrodes (3,4) is pressed to the solid polymer electrolyte membrane (5),

water flows on the both sides of the solid polymer electrolyte membrane (5), then

water containing ozone is produced at the anodic electrode (3) side by electrolysis of the flowing water, and

further comprising,

a setting device (82) for setting an initial value of the pressing force of the both electrodes (3,4) as against the solid polymer electrolyte membrane (5),

a concentration detection sensor (84) for detecting a concentration (X) of produced water containing ozone,

a first comparator (88a) for comparing the concentration (X) detected by a concentration

detection sensor (84) with a preset predetermined value (X_s),

a first command device (86a) for setting the current value (A) supplied between the both electrodes (3,4) according to a comparison signal from the first comparator (88a) so that the concentration (X) gets closer to a predetermined value (X_s),

a second command device (86b) by which the pressing force of the both electrodes (3,4) against the solid polymer electrolyte membrane (5) changes into a preset value to detect that an elapsed time (t) reaches a preset predetermined value (T_c) during run or that the concentration (X) reaches a preset control start concentration (X_m), and the pressing force returns to an initial value after a predetermined time elapses.

15. An apparatus for producing water containing ozone by electrolysis, wherein

an anodic electrode (3) having a catalyst function for generating ozone is disposed on one side of solid polymer electrolyte membrane (5),

a cathode electrode (4) is disposed on other side of solid polymer electrolyte membrane (5),

an advance and reverse mechanism is arranged

which enables the both electrodes (3,4) or at least one of them to advance and reverse against the solid polymer electrolyte membrane (5),

DC voltage is applied between the both electrodes (3,4) in the state that the both electrodes (3,4) is pressed onto the solid polymer electrolyte membrane (5),

water flows on the both sides of the solid polymer electrolyte membrane (5), then

water containing ozone is produced at the anodic electrode (3) side by electrolysis of the flowing water, and

further comprising,

a setting device (82) for setting an initial value of the pressing force of the both electrodes (3,4) as against the solid polymer electrolyte membrane (5),

a concentration detection sensor (84) for detecting a concentration (X) of produced water containing ozone,

a first comparator (88a) for comparing the concentration (X) detected by a concentration detection sensor (84) with a preset predetermined value (Xs),

a first command device (86a) for setting the current value (A) supplied between the both

electrodes (3,4) according to a comparison signal from the first comparator (88a) so that the concentration (X) gets closer to a predetermined value (Xs),

a second command device (86b) by which the pressing force of the both electrodes (3,4) against the solid polymer electrolyte membrane (5) changes into a preset value to detect that an elapsed time (t) reaches a preset predetermined value (Tc) during run or that the concentration (X) reaches a preset control start concentration (Xm), and the pressing force returns to an initial value after a predetermined time elapses,

a second comparator (88b) for determining that the current value (A) reaches a predetermined ceiling value of the apparatus (Ae),

a third command device (86c) by which the running apparatus is stopped when the second comparator (88b) detects that the current value reaches a predetermined ceiling value (Ae) and when it is detected the concentration (X) reaches a predetermined lower limit value (Xe), and the pressing force of the both electrodes (3,4) or one of them against the solid polymer electrolyte membrane (5) is released, then, the apparatus works again after a predetermined time elapses.

16. A recovery method of a solid polymer electrolyte membrane, using an apparatus for producing water containing ozone by electrolysis in which

an anodic electrode (3) having a catalyst function for generating ozone is disposed on one side of solid polymer electrolyte membrane (5),

a cathode electrode (4) is disposed on other side of solid polymer electrolyte membrane (5),

an advance and reverse mechanism is arranged, which enables the both electrodes (3,4) or at least one of them to advance and reverse against the solid polymer electrolyte membrane (5),

DC voltage is applied between the both electrodes (3,4) in the state that the both electrodes (3,4) are pressed to the solid polymer electrolyte membrane (5),

water flows on the both sides of the solid polymer electrolyte membrane (5), then

water containing ozone is produced at the anodic electrode (3) side by electrolysis of the flowing water, and

in order to recover an efficiency of the solid polymer electrolyte membrane (5) of which efficiency has deteriorated during producing the water containing ozone, an operation for changing the

pressing force is carried out wherein,

the pressing force of the anodic electrode (3), the cathode electrode (4) or the both of them against the solid polymer electrolyte membrane (5) changes in accordance with a preset condition, after that, returns to an original pressing force, thereby the efficiency of the solid polymer electrolyte membrane is restored.

17. The recovery method of a solid polymer electrolyte membrane as set forth in claim 17, wherein ,

the operation changing the pressing force has a pressure change pattern in which

a state that the pressing force decreases to a value less than a preset value or a state that the pressing force increases to a value more than another preset value, continues for a time more than a predetermined time.

18. A recovery method of a solid polymer electrolyte membrane, using an apparatus for producing water containing ozone by electrolysis in which

an anodic electrode (3) having a catalyst function for generating ozone is disposed on one side

of solid polymer electrolyte membrane (5),

a cathode electrode (4) is disposed on other side of solid polymer electrolyte membrane (5),

an advance and reverse mechanism is arranged which enables the both electrodes (3,4) or at least one of them to advance and reverse against the solid polymer electrolyte membrane (5),

DC voltage is applied between the both electrodes (3,4) in the state that the both electrodes (3,4) is pressed onto the solid polymer electrolyte membrane (5),

water flows on the both sides of the solid polymer electrolyte membrane (5), then

water containing ozone is produced at the anodic electrode (3) side by electrolysis of the flowing water, and

in order to recover an efficiency of the solid polymer electrolyte membrane (5) of which efficiency has deteriorated during producing the water containing ozone, an operation for changing the electric current or voltage is carried out wherein,

the current value (A) or the voltage value (V) changes rapidly according to a preset condition, after that, returns to an original value or the vicinity of it, thereby, an efficiency of the solid polymer electrolyte membrane recovers.

19. The recovery method of a solid polymer electrolyte membrane as set forth in claim 18, wherein ,

in the operation for changing the electric current or the voltage,

the electric current or voltage changes from a start point value of the operation and changes in a range between zero or a minimum value of the vicinity of it and a maximum permissible value of the apparatus for producing the water containing ozone, then, the states of the minimum value and the maximum permissible value are respectively kept for a predetermined time, after that,

the electric current or the voltage changes to the original value or the vicinity of it.

20. A recovery method of a solid polymer electrolyte membrane, wherein

an anodic electrode (3) and a cathode electrode (4) are respectively disposed on both sides of the solid polymer electrolyte membrane (5),

while an electrochemical reaction is carried out in the state that at least one of the both electrodes is pressed onto the solid polymer electrolyte membrane (5),

the pressing force of the anodic electrode (3), the cathode electrode (4) or the both of them against the solid polymer electrolyte membrane (5) changes in accordance with a preset condition, after that, returns to an original pressing force, thereby the efficiency of the solid polymer electrolyte membrane deteriorated in a reaction process is restored.

21. A recovery method of a solid polymer electrolyte membrane, wherein

an anodic electrode (3) and a cathode electrode (4) are respectively disposed on both sides to solid polymer electrolyte membrane (5),

while an electrochemical reaction is carried out in the state that at least one of the both electrodes is pressed onto the solid polymer electrolyte membrane (5),

the current value (A) or the voltage value (V) between the both electrodes (3,4) changes rapidly according to a preset condition, after that, returns to an original value or the vicinity of it, thereby, an efficiency of the solid polymer electrolyte membrane deteriorated in a reaction process is restored.